DOCUMENT RESUME

ED 354 992 PS 021 033

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TITLE The Lasting Benefits Study. A Continuing Analysis of the Effect of Small Class Size in Kindergarten through Third Grade on Student Achievement Test Scores in Subsequent Grade Levels: Fifth Grade. Technical Report.
INSTITUTION Tennessee State Univ., Nashville. Center of Excellence: Basic Skills.
PUB DATE 92
NOTE 54p.; Separately printed "Executive Summary" has been bound in. For the fourth grade Technical Report, see ED 338 440.
AVAILABLE FROM Publication Sales, Center for Research in Basic Skills, Tennessee State University, 330 10th Avenue, North, Suite J-1, Nashville, TN 37203 ($10.50).
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Academic Achievement; Achievement Tests; *Class Size; Elementary Education; *Elementary School Students; *Grade 5; Language Arts; Longitudinal Studies; Mathematics; Minority Groups; *Small Classes; *Teacher Student Ratio; White Students
IDENTIFIERS Lasting Benefits Study TN; Project STAR; *Student Teacher Achievement Ratio Project TN; Tennessee; Tennessee Comprehensive Assessment Program

ABSTRACT

Between 1985 and 1989, the Student Teacher Achievement Ratio (STAR) Project studied the effect of class size on student achievement in Tennessee schools. The study examined: (1) small classes of 13 to 17 students per teacher; (2) regular classes of 22 to 25 students per teacher; and (3) regular classes with a teacher's aide. The sample included students from kindergarten through third grade at inner-city, rural, urban, and suburban schools. Results showed achievement benefits for students from small classes over students from the other classes. A Lasting Benefits Study (LBS) is being conducted to determine if these achievement gains are maintained in later grades. This report discusses the LBS findings for fifth grade students. A standardized test battery measured the achievement in reading, language, math, science, and social studies of 4,649 students who had participated in Project STAR. Results indicated that students who had been in a Project STAR small class showed statistically significant advantages over students in the other class types on all achievement measures. A bibliography of 14 books is provided. Appendices define the school types studied in Project STAR and the LBS, and tabulate fifth grade students' mean scores on achievement measures in the LBS. (PM)

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THE LASTING BENEFITS STUDY:

A Continuing Analysis of the Effect of Small Class Size in Kindergarten Through Third Grade on Student Achievement Test Scores in Subsequent Grade Levels:

Fifth Grade

Technical Report

Barbara A. Nye, Research Director
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Lasting Benefits Study

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ABSTRACT

Tennessee's Project STAR (1985-1989) showed clear and consistent achievement benefits for kindergarten through third-grade students in small (1:15) classes vs. students in regular (1:24) classes or regular classes with a full-time teacher aide. There were approximately 6,000 students in the Project STAR sample. The Lasting Benefit Study (LBS) is being conducted to follow a sub-sample of Project STAR students to determine if achievement gains from small-class participation in third grade (or grades K-3) are maintained in later grades. At the end of fourth grade (1989-90 school year), one-full year after their last small-class experience, students (n=4,230) from Project STAR small classes showed clear, consistent, and statistically significant ($p \leq .01$ or better) advantages over Project STAR students from the other two class-size conditions on every measure and in all school locations. Fourth-grade effect sizes ranged from .11 to .16, always favoring Project STAR small-class students. The fifth-grade (1990-91 school year) LBS analysis (n=4,649) shows that K-3 small-class benefits are pervasive even after two-full years of participation in regular-size classes. Fifth-grade results remained both educationally and statistically significant ($p \leq .01$ or better), with effect sizes ranging from .17 to .34 in favor of the small-class students.

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THE LASTING BENEFITS STUDY:

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Executive Summary

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Lasting Benefits Study Fifth Grade Executive Summary[1]

The Student Teacher Achievement Ratio Project (Project STAR), Tennessee's four-year longitudinal class-size study, demonstrated that reduced class size (1:15) in kindergarten through third grade significantly enhanced student achievement. The Project STAR study consisted of three class-size interventions which were: small class size (13 to 17) students per teacher, regular (22 to 25), and regular (22 to 25) with a full-time teacher's aide. The Project STAR sample consisted of over 7,000 students in as many as 79 schools during each year of the four-year study. The 79 schools were classified according to four school-type locations which were inner-city, rural, urban, suburban (see Appendix A). Sample sizes for each grade level of Project STAR were: 6,328 kindergarten students in 79 schools, 6,835 first-grade students in 76 schools, 6,846 second-grade students in 75 schools, and 6,804 third-grade students in 75 schools. Researchers employed a "within-school" design so that all three class types existed in each Project STAR school. This reduced major sources of possible variation in student achievement attributable to school effects (e.g., community demographics, principal leadership, instructional materials). The study design employed conservative analysis using the class as the unit of measure, recognizing the effects of teacher and class on individual student achievement.

To determine if there were continuing effects or benefits of reducing the number of students in K-3 classes for the Project STAR students as they progressed through school, the Tennessee State Department of Education contracted with The Center of Excellence for Research in Basic Skills at Tennessee State University. The Center is conducting a longitudinal study to see if the gains for Project STAR small-class students in the primary grades continue to benefit their subsequent performance on state

[1] Details of Project STAR and the Lasting Benefits Study (LBS) have been presented in research papers, in published articles, and in the annual and final project reports. Project STAR and LBS Technical Reports can be obtained from Tennessee State University, Center of Excellence: Basic Skills, 330 10th Avenue North, Nashville, TN 37203-3401.

achievement tests in later grades after they return to regular-size classes. As resources permit, Center personnel, in cooperation with the State Department of Education, plan to study Project STAR students' performance through twelfth grade.

All students who had participated in Project STAR in at least the third-grade were eligible to be selected for the Lasting Benefits Study. The fifth-grade sample contained 4,649 students in 236 classes from 72 schools. Of these students, 1,578 had been in a small third-grade class, 1,467 in a regular class, and 1,604 in a regular class with a full-time teacher's aide. (See **Table 1**.) Approximately 2,845 of these students had been in a Project STAR class during second grade, 2,294 during first grade, and 1,080 during kindergarten. The fifth-grade LBS is a cross-sectional analysis of achievement scores among students who had been in the three class types. School location was no longer be considered a fixed effect as the Project STAR students began entering middle schools at the fifth-grade level.

Table 1
Lasting Benefits Study: Fifth Grade (1990-91)
Numbers and Percent of White and Minority Students by Class Type

	CLASS TYPE			
	Small	Regular	Regular/Aide	Total
RACE				
White	1081 (68.5%)	911 (62.1%)	1047 (65.3%)	3039
Minority	497 (31.5%)	556 (37.9%)	557 (34.7%)	1610
Total	1578 (100%)	1467 (100%)	1604 (100%)	4649

The Tennessee Comprehensive Achievement Program (TCAP) was the LBS measure of academic achievement. Fifth-grade, TCAP scaled score means for students from the three Project STAR class types (small, regular, regular-with-aide) were compared by a MANOVA for unequal n's using the MULTIVARIANCE program (Finn and Bock, 1985). Three achievement subsets for the LBS were compared separately. Two of the subsets included scores from both the norm-referenced test (NRT) component and the criterion-referenced test (CRT) component of the TCAP. Set 1 included Total Reading (NRT scores), Total Language (NRT scores) and the number of domains mastered in Language Arts (CRT). Set 2 consisted of Total Math (NRT scores), Total Science (NRT scores), and the number of domains mastered in Mathematics (CRT). Set 3 included Study Skills (NRT) and Social Studies (NRT) scores.

The fifth-grade LBS analysis yielded clear and consistent results concerning the NRT and the CRT scores. **Students who previously were in a small-size Project STAR class demonstrated that they had statistically significant ($p \leq .01$) advantages over students in other class types on every set of measurements.** For the small/regular contrast, every variable was significant ($p \leq .01$) and every variable set was significant ($p \leq .01$), and for the regular/regular-aide contrast, no variable or variable set was significant.

The Project STAR results indicated substantial educational benefits for students in small classes. The LBS fourth and fifth-grade results have shown that these benefits are sustained even after two-full years of instruction in regular-size classes. The fifth-grade advantage can be measured by the TCAP score differences between the small and regular classes, and between the regular-with-aide and regular classes as shown in **Table 2**. Fifth-grade students who had been in Project STAR small classes averaged from 10.62 to 8.08 higher scaled scores (NRT) and .84 to .68 more mean number of domains mastered (CRT) than students who had been in regular-sized Project STAR

Table 2

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)

Scaled Score Differences and the Differences in the
Mean Number of Domains Mastered Between
Small and Regular Class Students
and Between Regular/Aide and Regular Class Students

Achievement Measures	Small vs. Regular	Regular/Aide vs. Regular
Norm-Referenced	**Scaled Score Differences**	
Total Reading	10.53	.10
Total Language	8.21	-1.03
Total Math	8.08	-.34
Science	8.99	-2.66
Social Sciences	8.14	-1.31
Study Skills	10.62	-.85
	Difference in Mean Number of Domains Mastered	
Criterion-Referenced		
Language Arts: Domains Mastered	.84	.07
Mathematics: Domains Mastered	.68	.16

classes. Students who had been in regular-with-aide Porject STAR classes generally had slightly lower achievement outcomes than did fifth-grade students who had been in Project STAR regular-sized classes.

The interpretation of the importance of the difference in test scores depends on the variability of the measures calculated. Effect sizes, which are the differences between small and regular classes (or regular-with-aide and regular classes) divided by the standard deviation of the regular class, were calculated in the LBS analysis. **Table 3** provides estimates of the small class and regular-with-aide class effect sizes. Effect sizes ranged from .17 to .34 for the small/regular contrast. The regular-aide/regular contrast showed effect sizes ranging from -.05 to .07.

The absence of a statistically significant teacher-aide effect remains consistent. In some instances, students who had been in regular/aide classes scored slightly higher than students who had been in regular classes. On the NRT Total Reading, regular/aide students had a mean scaled score of 712.52 and students from regular classes had a mean score of 712.42, a difference of only one tenth of a scaled score. Regular/aide students mastered an average of 3.79 domains (CRT) and regular class-size students mastered 3.72 domains.

Students from STAR small classes retained their academic advantage from the small-class treatment and continued to perform significantly better than students from regular and from regular-with-aide classes. The positive effects from involvement in a small-size class still remain pervasive two full years after students returned to regular-size classes.

Table 3

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Summary of Estimates of Small Class and Regular/Aide Effect Sizes

Achievement Measures	Estimates of Effect Size: Small vs. Regular Contrast	Regular vs. Reg/Aide Contrast
Norm-Referenced		
Total Reading	.22	0.002
Total Language	.18	- 0.020
Total Math	.18	- 0.008
Science	.17	- 0.050
Social Science	.17	- 0.030
Study Skills	.18	- 0.010
Criterion-Referenced		
Language Arts: Domains Mastered	.34	0.030
Mathematics: Domains Mastered	.28	0.070

LASTING BENEFITS STUDY/PROJECT STAR - FIFTH GRADE ANALYSIS

Introduction and Synopsis of Project STAR Results[1]

The Student Teacher Achievement Ratio Project (Project STAR), Tennessee's four-year longitudinal class-size study, demonstrated that reduced class size (1:15) in kindergarten through third grade significantly enhanced student achievement. The Project STAR study consisted of three class-size interventions which were: small class size (13 to 17) students per teacher, regular (22 to 25), and regular (22 to 25) with a full-time teacher's aide. The Project STAR sample consisted of over 6,000 students in as many as 79 schools during each year of the four-year study. The 79 schools were classified according to four school-type locations which were inner-city, rural, urban, suburban (see Appendix A). Sample sizes for each grade level for Project STAR were: 6,328 kindergarten students in 79 schools, 6,835 first-grade students in 76 schools, 6,828 second-grade students in 75 schools, and 6,804 third-grade students in 75 schools. The study employed a "within-school" design which meant that all three class types existed in each Project STAR school. This reduced major sources of possible variation in student achievement attributable to school effects (i.e., community demographics, principal leadership, instructional materials, etc.). The study design employed conservative analysis using the class as the unit of measure, recognizing the effects of teacher and class on individual student achievement.

Overall findings of Project STAR indicated a significant (statistically and educationally) achievement advantage (specifically in reading and mathematics) for students in small classes. The most pronounced effect occurred in the first grade. First-grade students in small classes scored at the 64th percentile in reading and at the 59th percentile in math. Students in small classes consistently outperformed students in regular and regular-with-aide classes on all sub-scores of both achievement measures (Stanford Achievement Test or SAT, and Tennessee's criterion referenced test--Basic Skills First Test or BSF) at every grade level (K-3), and in all four school-type locations (rural, suburban, inner-city, urban).

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[1] Details of Project STAR and the Lasting Benefits Study have been presented in various research papers, in published articles, and in the annual and final project reports. The Project STAR Technical Report and other reports can be obtained from Tennessee State University, Center of Excellence: Basic Skills, 330 10th Avenue North, Nashville, TN 37203-3401.

The Lasting Benefits Study (LBS): Background and Context

To determine if there were continuing effects or benefits of reducing the number of students in K-3 classes for the Project STAR students as they progress through school, the Tennessee State Department of Education contracted with The Center of Excellence for Research in Basic Skills at Tennessee State University. The Center is conducting a longitudinal study to see if the gains for Project STAR small-class students in the primary grades have any lasting benefits on their subsequent performance on state achievement tests in later grades. Center personnel plan to study Project STAR students' performance through twelfth grade in cooperation with the State Department of Education as state and Center resources permit. The primary purpose of the Lasting Benefits Study (LBS) is to identify the longevity of positive effects on achievement scores that may be found for Project STAR students who were in small classes and who are now in regular-size classes.

An advisory committee was established by the Center to assist in the implementation of the Lasting Benefits Study. It included members of the Tennessee State Department of Education, the State Board, research consultants, two principal investigators from Project STAR, and principal investigators on the Lasting Benefits Study.

Fourth grade (1989-90 school year) LBS results indicated that one-full year after their last small-class experience, students (n=4,230) from Project STAR small classes had maintained clear, consistent, and statistically significant ($p \leq .01$ or better) advantages over Project STAR students from regular and regular-aide Project STAR classes. Fourth-grade effect sizes ranged from .11 to .16, always favoring Project STAR small-class students. These results were consistent for every achievement measure.

The LBS Measurement Processes

The Tennessee Comprehensive Achievement Program (TCAP) was selected as the LBS measure of academic achievement. This instrument was chosen because Tennessee requires all schools to administer the TCAP during the 2nd through the 8th grade and the 10th grade. Thus, the TCAP allows for a consistent measure of achievement across schools. The TCAP test battery includes both a norm-

referenced test (NRT) component and criterion-referenced test (CRT) component. The Comprehensive Tests of Basic Skills (CTBS/4) constitutes the norm-referenced test component. The CTBS/4, published by CTB/McGraw Hill, was nationally normed in 1988. The norm-referenced component indicates students' proficiencies in the areas of reading, language, math, study skills, science, and social studies. The criterion-referenced test component was customized for Tennessee to assess skill levels learned from the state's mathematics and language arts curriculum. The criterion-referenced component indicates students' mastery levels (i.e., mastery, partial mastery, or non-mastery) regarding the language arts and mathematics content domains. Mastery means that the student has correctly responded to at least 75% of the items in a particular domain. Partial mastery means competence was exhibited for 50-74% of the items and non-mastery represents scoring correctly for fewer than 50% of the items. The seven language arts content domains are: language mechanics, language usage, sentence and paragraph structure skills, spelling and word identification, reading comprehension, literary skills, and reference study skills. The nine mathematics content domains are: numeration, whole number operations, fractions, decimals, graphs and tables, measurement, geometry, problem solving and applications, and probability and statistics. (Tennessee Comprehensive Curriculum Objectives, 1989).

Sample

All students who had participated in Project STAR in at least the third-grade were eligible to be selected for the Lasting Benefits Study. Due to student mobility, these students may or may not have been Project STAR participants in previous grades. The LBS fourth-grade student sample contained 4,230 students in 216 classes.

During the fourth-grade (1989-90), one school system only administered the TCAP to a sample of their school population which resulted in 17 Project STAR schools without the necessary achievement measures. Therefore, students from these schools could not be participants in the fourth-grade Lasting Benefit Study. This reduced the number of minority students from 34.0% (third-grade) to 20.2%. The 17 exempt schools have begun to administer the TCAP and the original proportion of minority students has been restored.

The fifth-grade sample contained 4,649 students in 236 classes. Of these students, 1,578 had been in a small third-grade class, 1,467 in a regular class, and 1,604 in a regular class with a full-time teacher's aide. Approximately 2,845 students had been in one of the three Project STAR class types during second grade (1,032 in small, 779 in regular and 1,034 in regular/aide classes), 2,294 during first grade (852 in small, 619 in regular, and 823 in regular/aide classes), and 1,080 during kindergarten (570 in small, 210 in regular, and 300 in regular/aide classes). The 236 classes represented 72 schools throughout Tennessee. Of the 4,649 fifth-grade students, approximately 50% were male and 50% were female. The sample contained approximately 65% white students and 35% minority students. Sixty-eight percent of previous small-class students were white and 32% were minority. Similarly, there were 62% white students and 38% minority students from regular classes. The regular-with-aide student sample contained 65% white students and 35% minority students. (See **Table 1.**)

Table 1
Lasting Benefits Study: Fifth Grade (1990-91)
Numbers and Percent of White and Minority Students by Class Type

	CLASS TYPE		
	Small	Regular	Regular/Aide
RACE			
White	1081 (68.5%)	911 (62.1%)	1047 (65.3%)
Minority	497 (31.5%)	556 (37.9%)	557 (34.7%)
Total	1578 (100%)	1467 (100%)	1604 (100%)

Analysis Procedures

During Project STAR (1985-89), school systems used the Stanford Achievement Test (SAT) and Basic Skills First (BSF) achievement tests. Beginning with the 1989-90 school year, the first year of the LBS (fourth-grade), the state instituted a new test battery, the Tennessee Comprehensive

Assessment Program (TCAP). There is no direct means by which to conduct statistical comparisons between Project STAR K-3 achievement test scores and LBS achievement test scores.

The fourth-grade analysis employed a multivariate analysis of variance (MANOVA) that examined the mean differences among the class types, the mean differences among the four school locations (rural, urban, suburban, inner-city), and the interaction between class types and locations. The fifth-grade LBS is a cross-sectional analysis of achievement scores between class types. School location could no longer be considered a fixed effect as the Project STAR students began entering middle schools at the fifth-grade level. The transition to middle and eventually to high schools meant that: (1) students are or would be entering new schools, (2) some new schools were in different geographic locations, (3) students from different school locations would be integrated into one school. As a result, the location and location by class-type fixed effects and the classes within locations random effect are no longer included in the statistical design for fifth grade and later grades.

Fifth-grade scaled score means for the three Project STAR class types (small, regular, regular-with-aide) were compared by a MANOVA for unequal n's using the MULTIVARIANCE program (Finn and Bock, 1985)[2]. Three achievement subsets for the LBS were compared separately. Two of the subsets included scores from both the norm-referenced test (NRT) component and the criterion-referenced test (CRT) component of the TCAP. Set 1 included Total Reading (NRT scores), Total Language (NRT scores) and the number of domains mastered in Language Arts (CRT). Set 2 consisted of Total Math (NRT scores), Total Science (NRT scores), and the number of domains mastered in Mathematics (CRT). Set 3 included Study Skills (NRT) and Social Studies (NRT) scores. Overall MANOVAs were followed by F-ratios for those effects that were significant, and by Hotelling's T^2 and univariate t-tests for two particular contrasts. The two contrasts were (1) Small class vs. Regular class and (2) Regular-with-aide class vs. Regular class. A Small/Regular-with-aide contrast was not conducted because no mean differences were found between Project STAR Regular and Regular-with-aide classes in kindergarten, and because students were randomly interchanged between these two class

[2] Dr. Jeremy Finn, a nationally recognized educational statistician from the State University of New York at Buffalo, who is currently working at the National Center for Educational Statistics, served as a statistical consultant for the Lasting Benefits Study.

types before grade one. [3] The MANOVA model controlled for the "class-type" fixed effect, and the random effects of "classes by class type" and "students within classes and class types". The sources of variation are depicted in **Table 2**.

Table 2
Lasting Benefits Study: Fifth Grade (1990-91)
Analysis of Variance Source Table

Fixed Effects	Error Term
Class Type	CT

Random Effects

Classes x Class Type (CT)

Students within Classes and Class Types

LBS Fifth-Grade Results

The fifth-grade LBS analysis yielded clear and consistent results concerning the NRT and the CRT scores. **Students who previously were in a small-size Project STAR class demonstrated that they had statistically significant (p. $\leq$ .01) advantages over students in other class types on every set of measurements.** Probability ("p") values are statistical estimates of the probability that the mean differences observed in the data could have occurred purely by chance. Multivariate Analysis of Variance (MANOVA) produces these probability statements by estimating "real effects" and "error effects" with mathematical formulas that involve means, standard deviations, and variances on test scores for specified groups of students which were sorted by classes and by class type. When $p \leq .01$, the mean differences for the specified groups are said to show a "statistically significant" difference on the specified test score. This is significant because this amount of difference would have occurred due

[3] Due to a limited number of teacher-identified discipline problems and parent complaints, and because there were no differences on any measure for students in regular and regular-with-aide classes, some STAR students were randomly reassigned within these two classes for the first grade. This is the only year that reassignment occurred. There were no reassignments of small class students.

purely to "chance" less than 1 time out of 100. "NS" means "not significant", that is "p" is greater than .05 (the critical level of "p" that was set prior to the study for testing statistical significance.) For the small/regular contrast, every variable was significant ($p \leq .01$) and every variable set was significant ($p \leq .01$), and for the regular/regular-aide contrast, no variable or variable set was significant.

Table 3 shows the mean number of domains mastered in reading and mathematics from the CRT component by class type. Of the nine math domains, 3.68 were mastered by small-class students, 3.00 were mastered by regular-class students, and 3.16 were mastered by the regular-with-aide students. Similarly, of the seven language arts domains, 4.56 were mastered by small-class students, 3.72 were mastered by the regular-class students, and 3.79 were mastered by the regular-with-aide students. Exact means of the number of CRT domains mastered by class type and by race are presented in **Appendix B**.

TABLE 3
Lasting Benefits Study: Fifth Grade (1990-91)
Mean Number of Domains Mastered in Mathematics and Language Arts*
by Class Type

	CLASS TYPE		
	Small	Regular	Regular/Aide
Language Arts	4.56	3.72	3.79
Mathematics	3.68	3.00	3.16

*The 7 language arts domains from the TCAP are: language mechanics, language usage, sentence and paragraph structure, spelling and word identification, reading comprehension, literary skills, and reference study skills. The 9 mathematics domains from the TCAP are: numeration, whole number operations, fractions, decimals, graphs and tables, measurements, geometry, problem solving and applications, and probability and statistics.

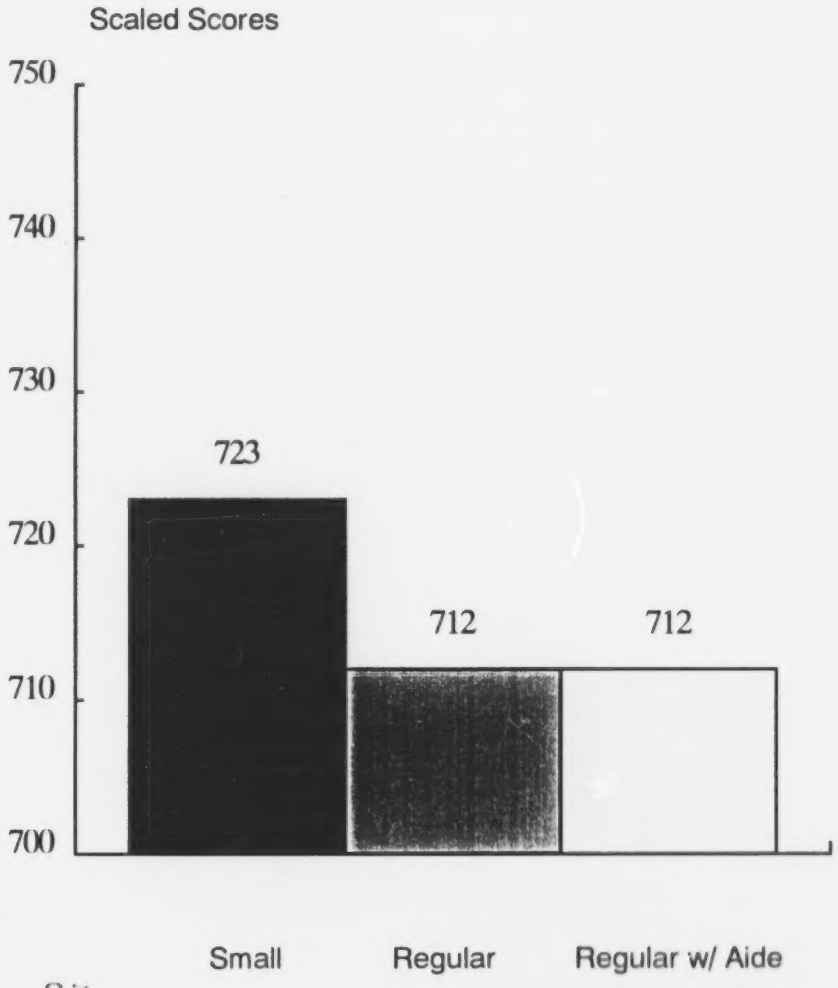
The results of the NRT scales of the TCAP showed statistically significant effects for students who had been in small classes. **Figure 1** presents the mean scaled scores and respective percentile ranks for the **TCAP Total Reading sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$--"p" meaning the probability that mean differences occurred purely by chance) than students who had been in regular and regular-with-aide classes. Small-class students had a mean Total Reading scaled score of 723 (51st percentile), regular-class students scored 712 (41st percentile) and regular-with-aide class students scored 713 (42nd percentile). The TCAP Total Reading scaled score is derived from vocabulary and comprehension. Small-class students outscored students from regular and regular-with-aide classes on both vocabulary and comprehension. Small-class students averaged 714 (48th percentile), regular-class students 703 (38th percentile), and regular-with-aide class students 704 (39th percentile) on the vocabulary component score. On the comprehension score small-class students averaged 730 (52nd percentile), regular-class students 721 (43rd percentile), and regular-with-aide class students 722 (44th percentile).

Figure 2 presents the mean scaled scores and respective percentile ranks for the **TCAP Total Language Sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$) than students who had been in regular and regular-with-aide classes. Small-class students had a mean Total Language scaled score of 726 (52nd percentile), regular-class students scored 718 (44th percentile) and regular-with-aide class students scored 717 (43rd percentile). The TCAP Total Language scaled score is derived from mechanics and expression. Small-class students outscored students from regular and regular-with-aide classes on both mechanics and expression. Small-class students averaged 721 (52nd percentile), regular-class students 715 (47th percentile), and regular-with-aide class students 713 (45th percentile) on the mechanics component score. On the expression score small-class students averaged 729 (47th percentile), regular-class students 720 (40th percentile), and regular-with-aide class students 722 (38th percentile).

Figure 3 presents the mean scaled scores and respective percentile ranks for the **TCAP Total Mathematics Sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$) than students who had been in regular and regular-with-aide classes. Small-class students had a mean

Figure 1

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Reading by Class Type



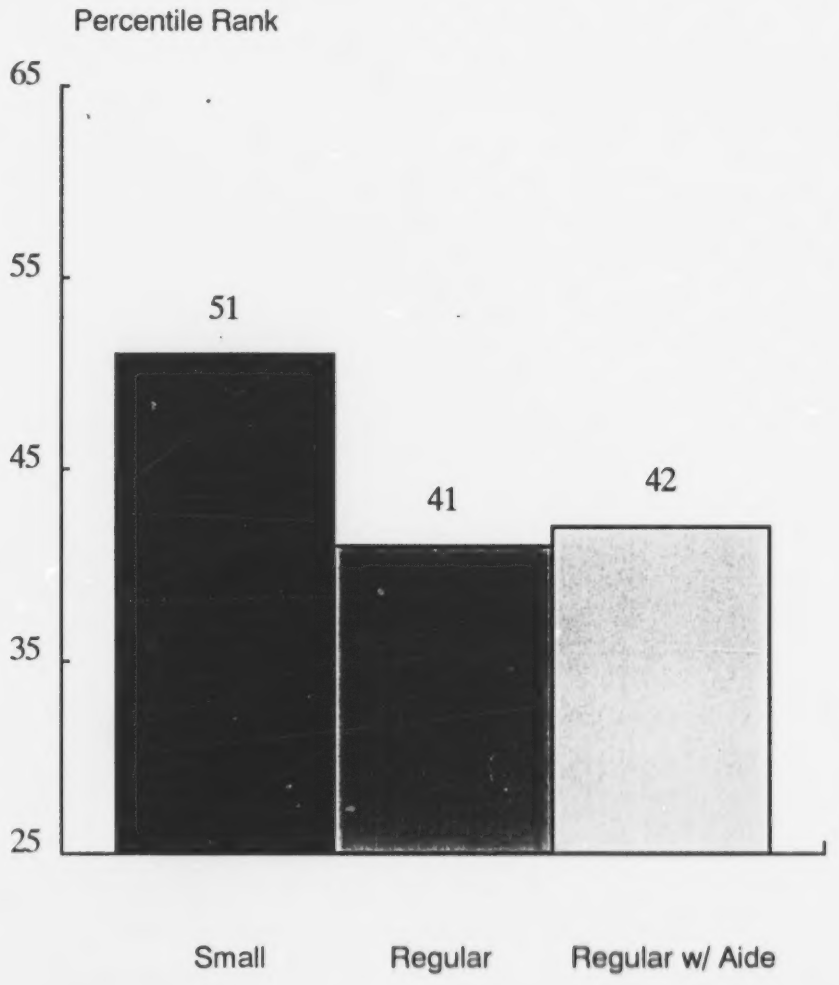


Figure 2

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Language by Class Type

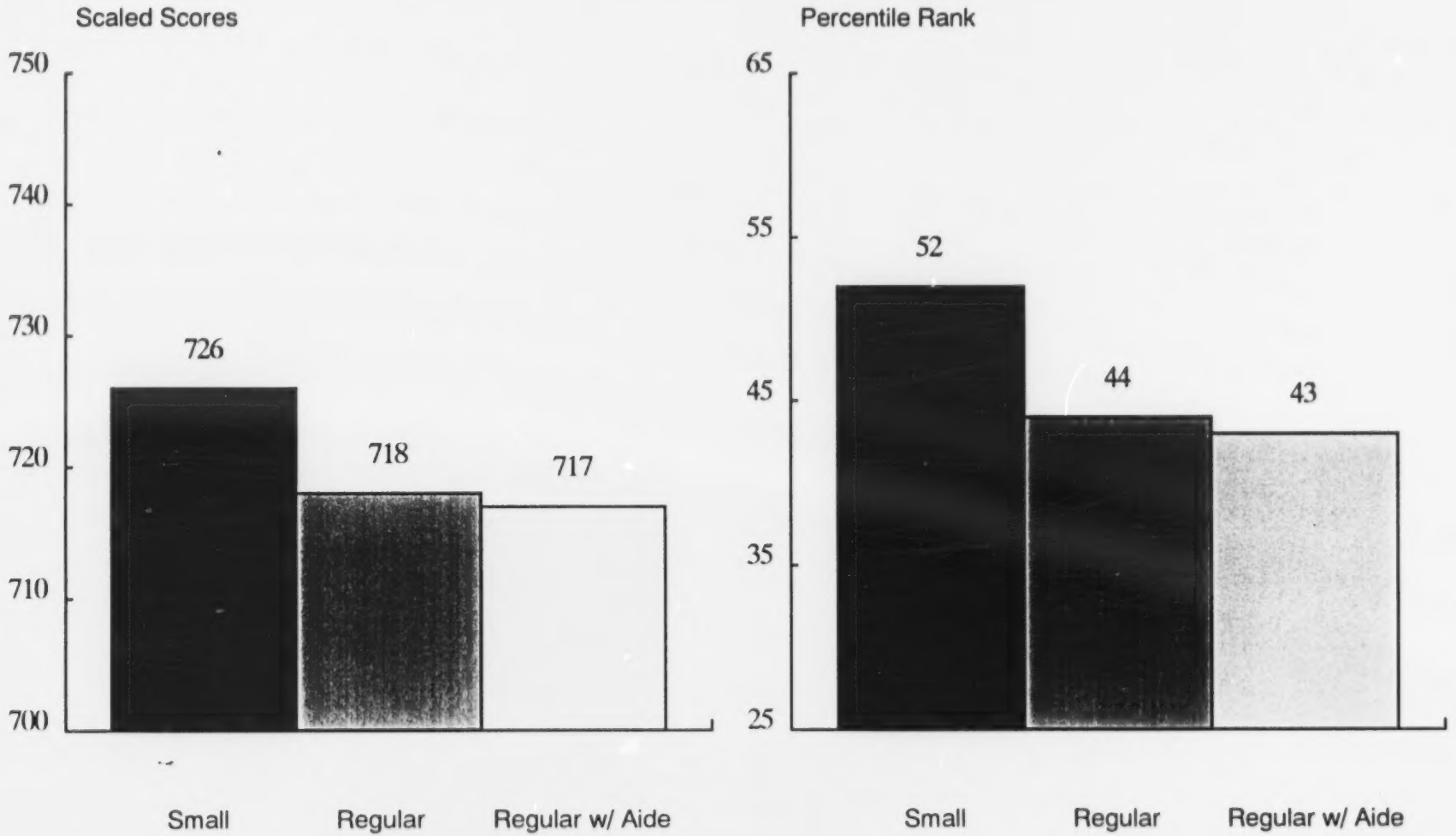
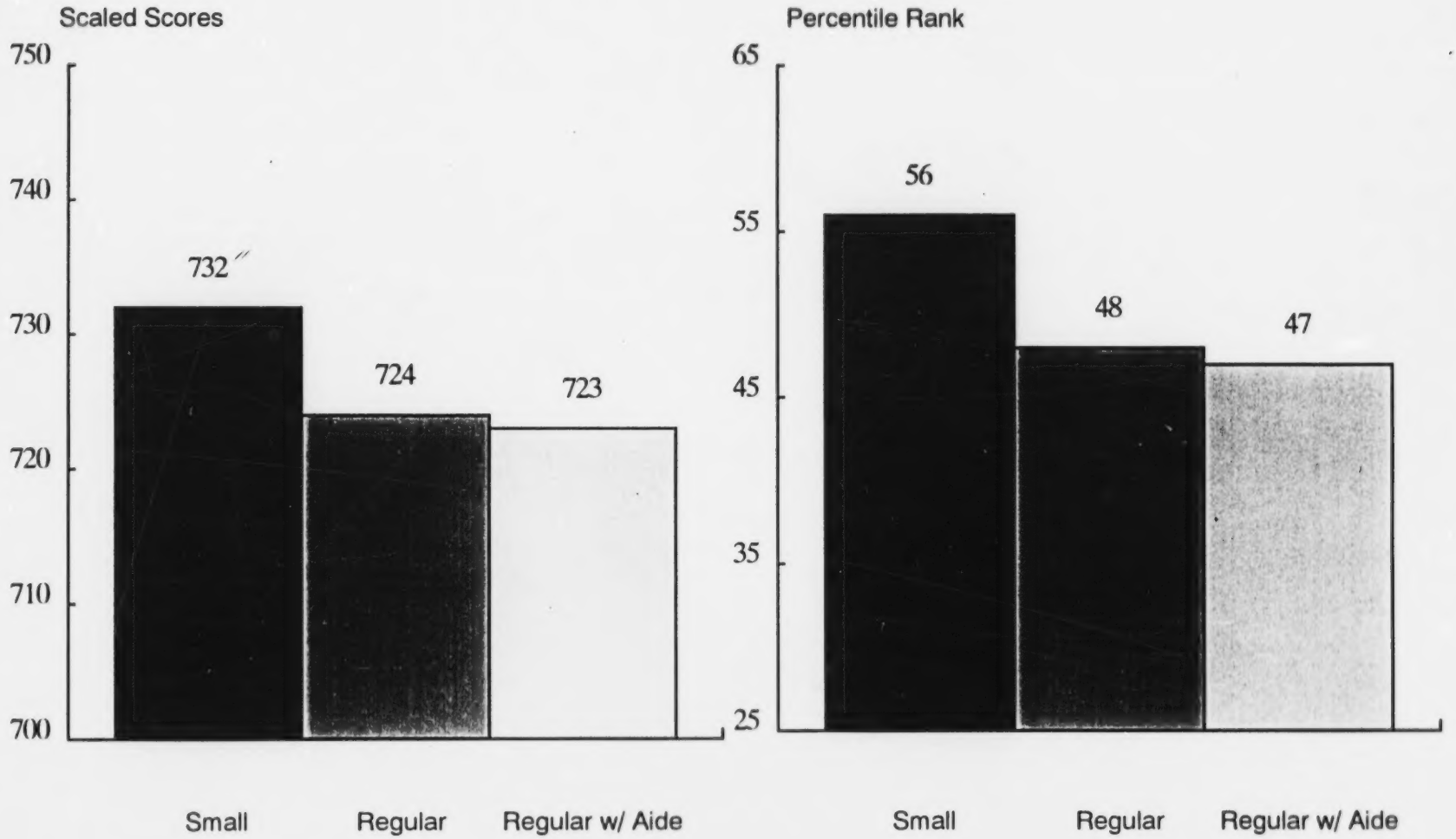


Figure 3

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Math: Class Type by School Type



Total Mathematics scaled score of 732 (56th percentile), regular-class students scored 724 (48th percentile) and regular-with-aide class students scored 723 (47th percentile). TCAP Total Math scaled score is determined from two component scores, computation and concepts and applications. On the computation score small-class students averaged 734 (56th percentile), regular-class students 728 (49th percentile), and regular-with-aide class students 729 (50th percentile). On the concepts and applications score small-class students averaged 725 (50th percentile), regular-class students 718 (39th percentile), and regular-with-aide class students 718 (39th percentile).

Figure 4 presents the mean scaled scores and respective percentile ranks for the **TCAP Study Skills Sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$) than students who had been in regular and regular-with-aide classes. Small-class students had a mean scaled score of 723 (52th percentile), regular-class students scored 712 (44th percentile) and regular-with-aide class students scored 711 (43rd percentile).

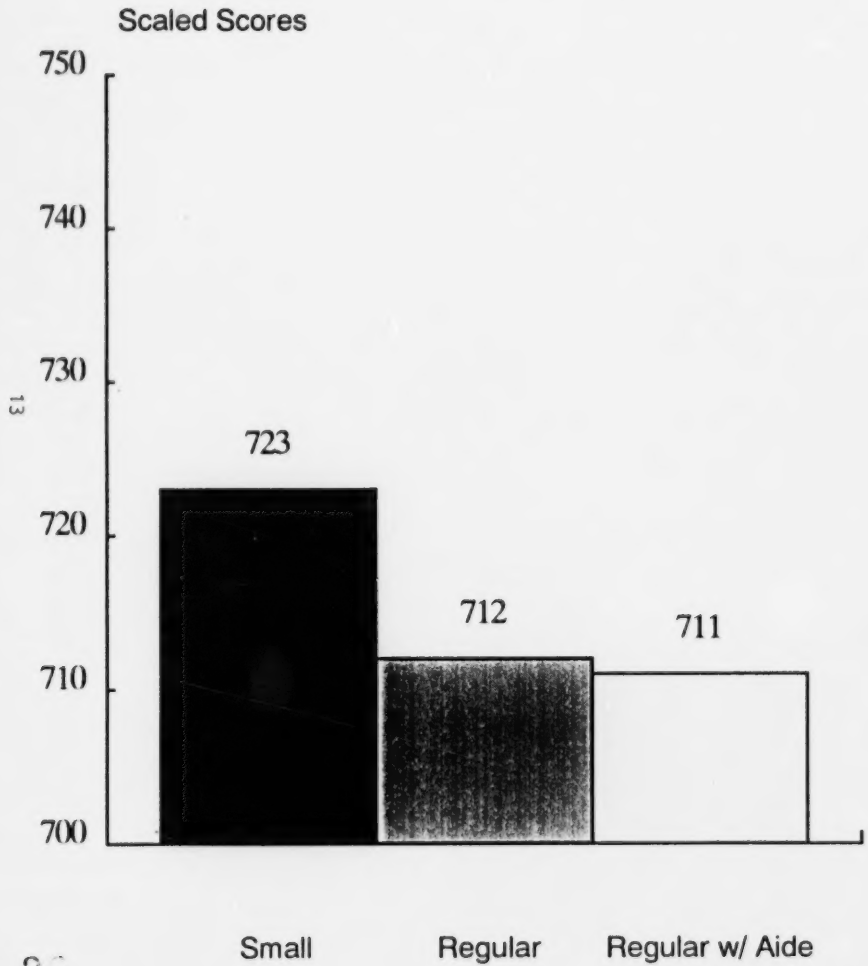
Figure 5 presents the mean scaled scores and respective percentile ranks for the **TCAP Science Sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$) than students who had been in regular and regular-with-aide classes. Small-class students had a mean scaled score of 730 (48th percentile), regular-class students scored 721 (41st percentile) and regular-with-aide class students scored 718 (39th percentile).

Figure 6 presents the mean scaled scores and respective percentile ranks for the **TCAP Social Studies Sub-score**. Of the three class types, students who were in small classes scored higher ($p \leq .01$) than students who had been in regular and regular-with-aide classes. Small-class students had a mean scaled score of 743 (58th percentile), regular-class students scored 735 (50th percentile) and regular-with-aide class students scored 733 (48th percentile). These NRT results (**Figures 1-6**) are also presented in table form in **Appendix B**. These tables provide the exact scaled score means for each reported NRT sub-score by class type and by race.

In order to determine the benefits regarding race, an approximate analysis was conducted during the fourth-grade LBS analysis to identify any interaction of race with class type on the achievement measures. Complete and correct analysis of the data which would allow for the possibility of white

Figure 4

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Study Skills by Class Type



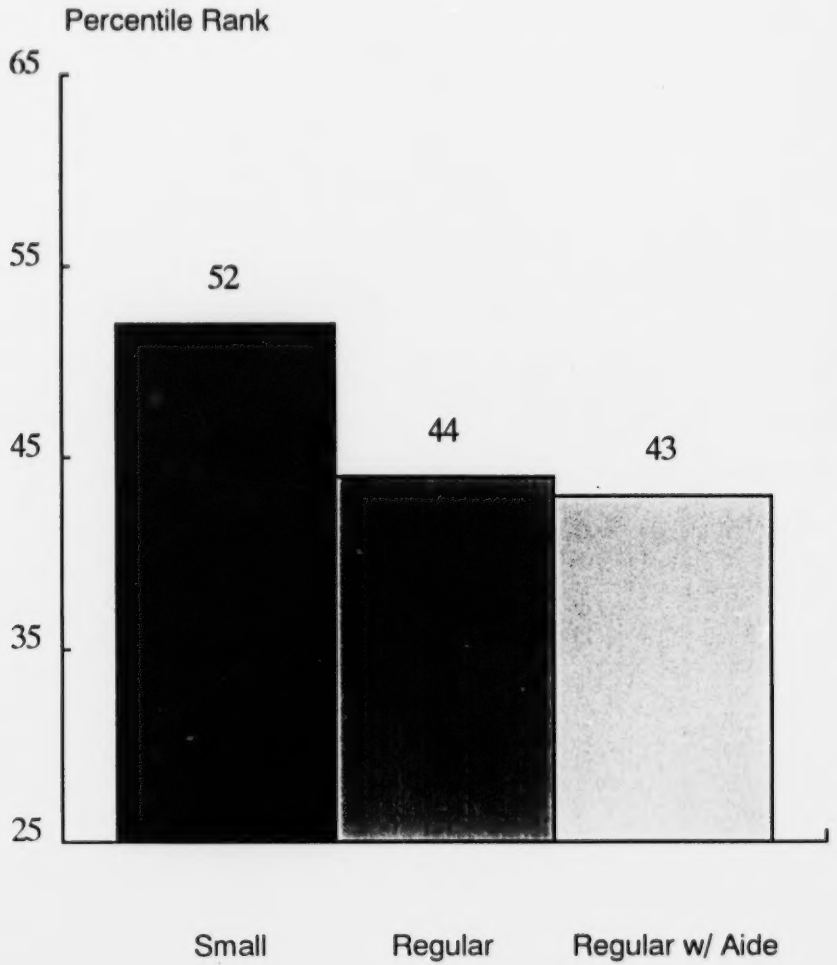


Figure 5

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Science by Class Type

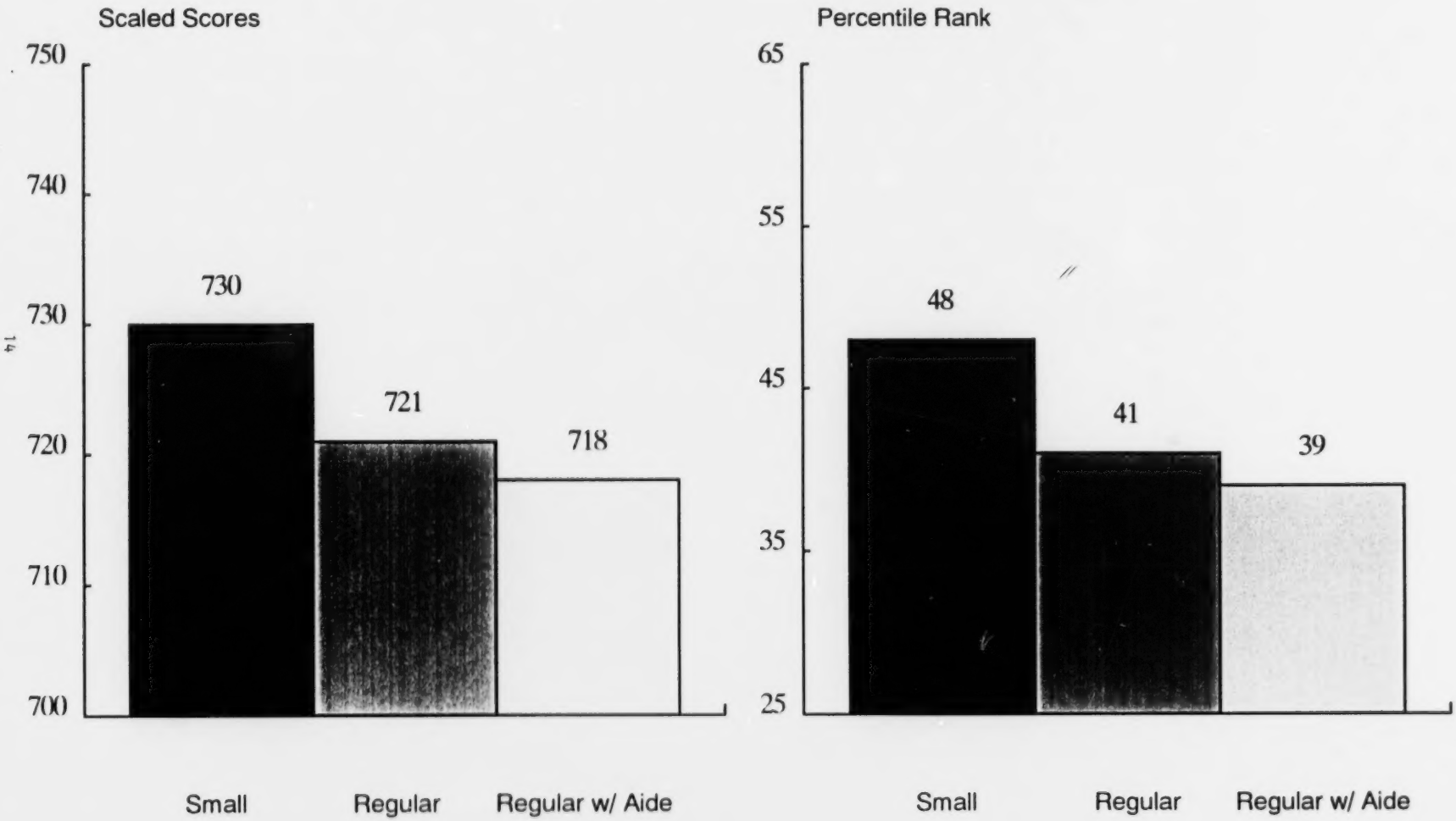
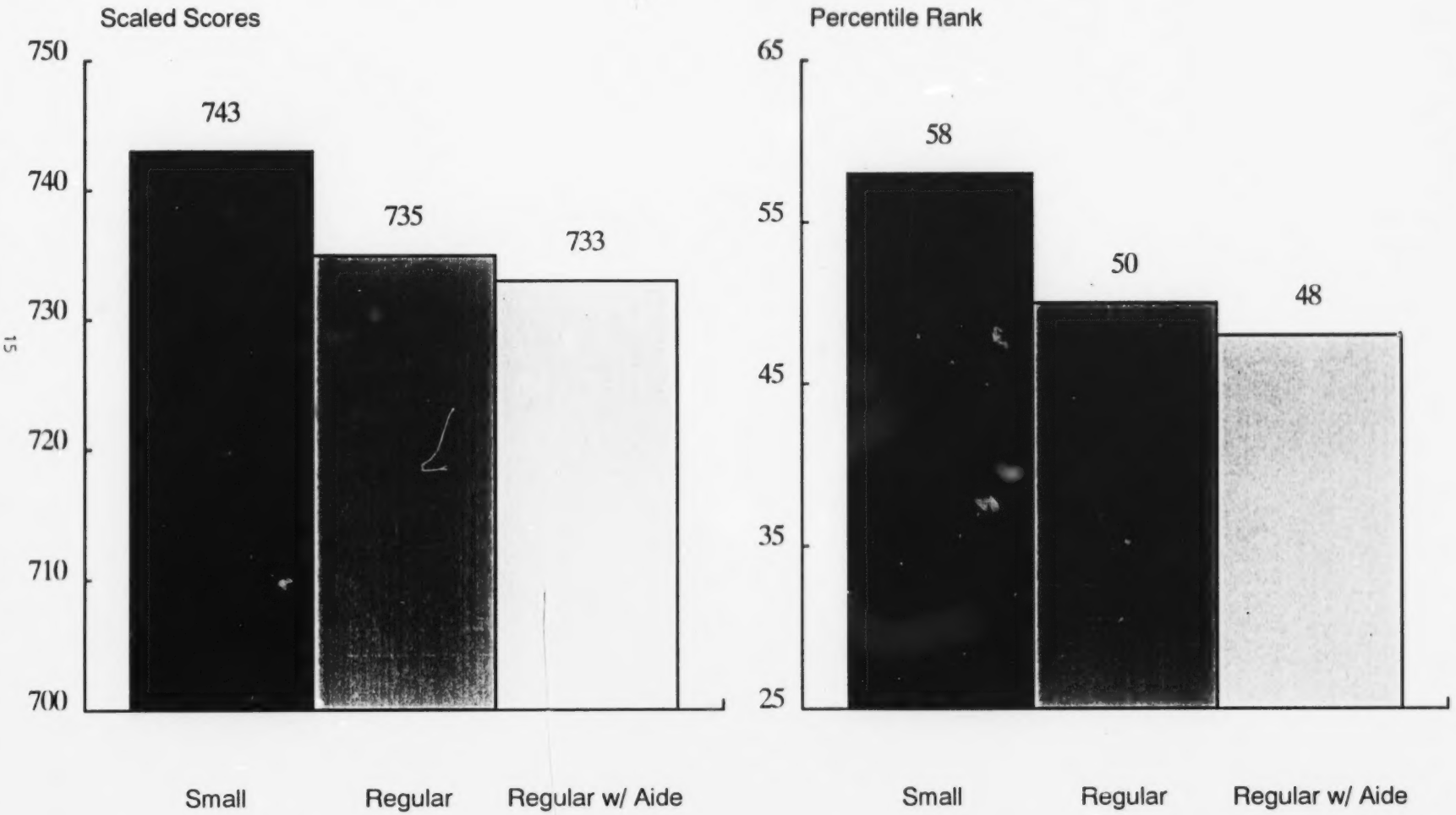


Figure 6

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Norm-Referenced Total Social Studies by Class Type



and minority students in the same classroom, while still maintaining the control for classes (i.e. teaching styles, strategies, etc.), was unwieldy.[4] An alternative "liberal" analysis for the increased degrees of freedom found no multivariate tests were significant for the interactions of race with class type or for race with school location. Although Project STAR results on K-3 test scores indicated that the most significant small-class advantages were found with minority students, the LBS fourth-grade results showed that the positive effects of small classes were equally significant for minority and white students.

Fifth-grade TCAP scores also indicate that small classes are equally beneficial for minority and white students. A higher percentage of whites are mastering the CRT mathematics domains. However, in the sixth mathematics domain, "measurements", one percent more minority students are mastering this domain than white students. (See **Table 4.**) Although white students are mastering more total mathematics domains, **Table 5** shows that minority students who had been in small classes always master more domains than minorities from regular and regular/aide classes. Minority small-class students mastered an average of 3.07 mathematics domains and 3.60 language arts domains. Minority students who had been in regular classes mastered an average of 2.43 mathematics domains and 2.78 language arts domains, and those from regular/aide classes mastered 2.59 and 2.82 mathematics and language arts domains respectively.

Similarly, NRT results from the TCAP show that small classes are beneficial for minority students and for white students. White students had higher mean scaled scores than minority students. However, minority students from small classes always outscore the minority cohorts from regular and regular/aide classes. (See **Table 6.**)

No multivariate tests of significance were performed to assess the effects of the K-3 small classes by race for the fifth-grade LBS sample. However, it is reasonable to conclude from the comparison of test scores that small classes are at least equally beneficial for minority students.

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[4]However, the error term for the mean square classes-x- race-x-class type was alternatively used because earlier work with these data indicated that the primary class-type interactions with race approximated the mean square for students within racial groups within classes.

Table 4

Lasting Benefits Study: Fifth Grade (1990-91)

Percentage of Students Mastering Mathematics and Language Arts Domains*
by Class Type by Race

	CLASS SIZE								
	SMALL			REGULAR			REGULAR/AIDE		
MATHEMATICS DOMAINS	White	Minority	Total	White	Minority	Total	White	Minority	Total
Numeration	29.8	19.6	26.6	23.0	15.5	20.2	27.1	18.9	24.2
Whole number operations	70.0	65.4	68.5	61.0	51.6	57.5	63.7	58.8	62.0
Fractions	32.3	23.0	29.4	25.9	17.4	22.7	27.2	20.1	24.7
Decimals	48.7	39.4	45.8	39.3	31.7	36.4	41.0	35.9	39.2
Graphs and tables	81.7	63.4	76.0	76.2	51.4	66.8	73.9	57.3	68.1
Measurements	23.0	24.6	23.5	18.0	19.1	18.5	19.4	25.1	21.4
Geometry	25.3	9.3	20.2	19.0	10.1	15.7	22.9	10.1	18.5
Problem solving and applications	61.1	37.6	53.7	52.0	25.6	42.0	54.0	26.0	44.3
Probability and statistics	25.1	25.1	25.1	21.0	20.9	21.0	23.5	19.1	22.0

	SMALL			REGULAR			REGULAR/AIDE		
LANGUAGE DOMAINS	White	Minority	Total	White	Minority	Total	White	Minority	Total
Language Mechanics	84.6	69.5	79.9	73.8	56.0	67.1	73.6	59.6	68.7
Language Usage	86.1	70.9	81.3	77.9	52.3	68.2	78.0	58.3	71.1
Sentence and Paragraph Structure	58.9	40.4	53.1	50.5	29.2	42.5	48.6	29.3	41.9
Spelling and Word Identification	81.9	64.0	76.3	73.7	55.9	66.9	76.0	61.0	70.8
Reading Comprehension	72.5	48.8	65.1	60.6	34.6	50.8	63.1	40.8	55.3
Literary Skills	54.7	28.7	46.5	40.4	21.8	33.4	44.1	16.7	34.6
Reference Study Skills	62.1	37.8	54.4	52.0	27.9	42.9	53.6	28.7	44.9

*Mastery means that the student has correctly responded to at least 75% of the items in a particular domain.

Table 5

Lasting Benefits Study: Fifth Grade (1990-91)
Mean Number of Domains Mastered in Mathematics and Language Arts*
by Class Type by Race

CRITERION-REFERENCE TEST COMPONENT

CLASS TYPE	Mathematics			Language Arts		
	White	Minority	All	White	Minority	All
Small	3.96	3.07	3.68	5.00	3.60	4.56
Regular	3.35	2.43	3.00	4.29	2.78	3.72
Regular/aide	3.47	2.59	3.16	4.31	2.82	3.79

*The 9 Mathematics domains from the TCAP are: numeration, whole number operations, fractions, decimals, graphs and tables, measurements, geometry, problem solving and applications, and probability and statistics. The 7 Language Arts domains from the TCAP are: language mechanics, language usage, sentence and paragraph structure, spelling and word identification, reading comprehension, literary skills, and reference study skills.

Table 6

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Mean Scaled Scores by Race and Class Type

ACHIEVEMENT MEASURES		CLASS TYPE		
		Small	Regular	Regular/Aide
Total Reading	White	730.55	722.06	720.31
	Minority	706.34	696.63	697.91
Total Language	White	731.57	725.72	723.52
	Minority	714.91	705.66	705.03
Total Math	White	735.00	729.23	726.35
	Minority	724.45	714.41	717.49
Science	White	740.39	733.08	728.65
	Minority	706.62	700.65	698.41
Social Science	White	749.15	742.28	739.77
	Minority	728.97	722.26	721.37
Study Skills	White	728.65	721.03	717.47
	Minority	710.00	697.65	699.75

Summary and Conclusions

The Project STAR findings and the LBS fourth-grade results indicated substantial educational benefits for students who were instructed in small K-3 classes. Similarly, the LBS fifth-grade students who had attended small Project STAR classes had an educationally and statistically significant advantage over the LBS students who had attended regular or regular-with-aide Project STAR classes. Small-class students outperformed all other students on the six NRT sub-scores of the TCAP. Results for the CRT component of the TCAP were similar to those of the NRT component. The achievement advantage for small-class students can be measured by the TCAP scaled scores differences between the small and regular classes, and between the regular-with-aide and regular classes as shown in **Table 7**. Students from the small classes retained their academic advantage from the small-class treatment and continue to perform significantly better than students from regular and regular-with-aide classes. The positive effects from involvement in a small-size class still remain pervasive two full years after students returned to regular-size classes. As was the case with the longitudinal research on the effects of pre-school (Head Start) programs (Weikart, 1974), the Project STAR class-size intervention effect may diminish in some subsequent school years and reappear in others. Thus, longitudinal analysis is necessary on Tennessee's nationally recognized Project STAR to develop a comprehensive assessment of the pervasive benefits of the small-class intervention.

The interpretation of the importance of the difference in test scores depends on the variability of the measures calculated. Effect sizes which are the differences between small and regular classes (or regular-with-aide and regular classes) divided by the standard deviation of the regular class were calculated in the LBS analysis. **Table 8** provides estimates of the small class and regular-with-aide class effect sizes. It shows effect sizes ranging from .17 to .34 for the small/regular contrast. The regular-aide/regular contrast shows effect sizes ranging from -.05 to .07.

The absence of a statistically significant teacher/aide effect is consistent across all measures. In some instances, students who had been in regular/aide classes scored slightly higher than students who

Table 7

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)

Scaled Score Differences and the Differences in the
Mean Number of Domains Mastered Between
Small and Regular Class Students
and Between Regular/Aide and Regular Class Students*

Achievement Measures	Small vs. Regular	Regular/Aide vs. Regular
Norm-Referenced		
Total Reading	10.53	.10
Total Language	8.21	-1.03
Total Math	8.08	-.34
Science	8.99	-2.66
Social Sciences	8.14	-1.31
Study Skills	10.62	-.85
Criterion-Referenced		
Language Arts: Domains Mastered	.84	.07
Mathematics: Domains Mastered	.68	.16

*Exact means are tabled in Appendix B.

Table 8

Lasting Benefits Study: Fifth Grade (1990-91)
Tennessee Comprehensive Assessment Program (TCAP)
Summary of Estimates of Small Class and Regular/Aide Effect Sizes

Achievement Measures	Small vs. Regular Contrast	Regular vs. Reg/Aide Contrast
Norm-Referenced		
Total Reading	.22	0.002
Total Language	.18	-0.02
Total Math	.18	-0.008
Science	.17	-0.05
Social Science	.17	-0.03
Study Skills	.18	-0.01
Criterion-Referenced		
Language Arts: Domains Mastered	.34	0.03
Mathematics: Domains Mastered	.28	0.07

had been in regular classes. On the NRT Total Reading regular/aide students had a mean scaled score of 712.52 and students from regular classes had a mean score of 712.42, a difference of only one tenth of a scaled score. Regular/aide students mastered an average of 3.79 and regular students mastered 3.72 language arts domains. Similarly there was a slight difference in the number of mathematics domains mastered. Regular/aide students mastered 3.16 and students from regular classes mastered 3.00 mathematics domains. These meager differences were not statistically significant.

The statistically significant advantages for LBS fifth-grade students, who had been in Project STAR small classes, form a strong pattern of consistency. Small-class students outperformed regular and regular-with-aide class students on every achievement measure. The Lasting Benefits Study which is based on the nationally recognized Project STAR will continue to provide important data and information for making educational policy decisions.

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Appendix A.

Definition of School Types

The legislation specified that the project should include "inner city, suburban, urban, and rural schools" to assess the effects of class size in different types of schools. No existing designation of schools had used the categories specified above, so the consortium developed designations using various criteria.

Inner-city and suburban schools are all located in metropolitan areas. Schools that had more than half of their students on free or reduced cost lunch (indicative of a low-socioeconomic background) were tentatively defined as inner-city. Schools in the outlying areas of metropolitan cities were classified as suburban.

In non-metropolitan areas, schools were classified as urban or rural depending on the location of the school. If located in a town of over 2,500 population (the census definition of urban), the school was classified as urban. All other schools were classified as rural. All classifications were checked with local school officials to see if they agreed with the designation of their school.

Appendix B.

Lasting Benefits Study: Fifth Grade (1990-1991)
Mean Scores from the Tennessee Comprehensive Assessment Program (TCAP)

Norm-Referenced Test (NRT)--Scaled Scores

TCAP Total Reading

	Small	Regular	Regular/Aide
White	730.55	722.06	720.31
Minority	706.34	696.63	697.91
All	722.95	712.42	712.52

TCAP Total Language

	Small	Regular	Regular/Aide
White	731.57	725.72	723.52
Minority	714.91	705.66	705.03
All	726.34	718.13	717.10

TCAP Total Mathematics

	Small	Regular	Regular/Aide
White	735.00	729.23	726.35
Minority	706.62	700.65	698.41
All	731.69	723.61	723.27

TCAP Study Skills

	Small	Regular	Regular/Aide
White	728.65	721.03	717.47
Minority	710.00	697.65	699.75
All	722.80	712.18	711.33

TCAP Science

	Small	Regular	Regular/Aide
White	740.39	733.08	728.65
Minority	706.62	700.65	698.41
All	729.80	720.81	718.15

TCAP Social Science

	Small	Regular	Regular/Aide
White	749.15	742.28	739.77
Minority	728.97	722.26	721.37
All	742.83	734.69	733.38

Criterion-Reference Test (CRT)--Number of Domains Mastered

TCAP Language Arts

	Small	Regular	Regular/Aide
White	5.0046	4.2887	4.3086
Minority	3.6000	2.7766	2.8205
All	4.5635	3.7162	3.7912

TCAP Mathematics

	Small	Regular	Regular/Aide
White	3.9648	3.3520	3.4651
Minority	3.0727	2.4281	2.5871
All	3.6842	3.0014	3.1600